

CLAIMS

What is claimed is:

1. A method for separating a particulate feed comprising a first particle type and a second particle type, the method comprising the steps of
providing a separation apparatus comprising
a separation vessel having a top and a bottom, wherein the separation vessel includes inwardly sloping side walls with a greater spacing at their top ends than at their bottom ends, and
a magnet structure having
a first pole positioned exterior of and adjacent to each of the side walls of the separation vessel, and
a second pole positioned above the separation vessel; thereafter
introducing a mixture of the particulate feed and a ferrofluid into the separation vessel; and thereafter
permitting the particulate feed to separate into
a first particle fraction comprising more of the first particle type than the second particle type, wherein the first particle fraction sinks in the ferrofluid of the separation vessel, and
a second particle fraction comprising more of the second particle type than the first particle type, wherein the second particle fraction floats in the ferrofluid of the separation vessel away from the side walls of the separation vessel.
2. The method of claim 1, wherein the step of providing includes the step of providing the first pole as a north pole and the second pole as a south pole.
3. The method of claim 1, wherein the step of providing includes the step of providing the separation vessel as a closed vessel.

4. The method of claim 1, wherein the step of providing includes the step of providing the separation vessel with an opening at its bottom, from which the first particle fraction may be withdrawn.

5. The method of claim 1, wherein the step of permitting includes the step of permitting the particulate feed to separate quiescently.

6. The method of claim 1, wherein the step of providing includes the step of providing the separation vessel as an elongated trough having a first end and a second end, and wherein the step of permitting includes the step of flowing the particulate feed along the elongated trough from the first end toward the second end.

7. The method of claim 1, wherein the step of providing includes the step of providing the separation vessel as an elongated trough having a first end and a second end, and wherein the step of permitting includes the step of flowing the particulate feed along the elongated trough from the first end to the second end, wherein the first particle fraction and the second particle fraction are removed at positions between the first end and the second end.

8. The method of claim 7, wherein the step of providing includes the step of providing a passive separator surface between the first end and the second end of the trough, and wherein the step of flowing includes the steps of:
removing the first particle fraction from below the separator surface, and
removing the second particle fraction from above the separator surface.

9. The method of claim 7, wherein the step of permitting includes the step of recycling a portion of one of the first particle fraction and the second particle fraction to the first end as a recycled portion, and

reflowing the recycled portion along the elongated trough.

10. The method of claim 9, wherein the step of recycling includes the step of pumping the recycled portion from the second end to the first end of the elongated trough.

11. The method of claim 7, wherein the step of permitting includes the steps of: recycling a portion of the second particle fraction to the first end as a recycled portion, and reflowing the recycled portion along the elongated trough.

12. The method of claim 1, wherein the step of permitting includes the step of ultrasonically agitating the mixture of the particulate feed and the ferrofluid.

13. The method of claim 1, wherein the step of introducing includes the step of introducing the first particle type as a metal and the second particle type as a ceramic.

14. The method of claim 1, wherein the step of introducing includes the step of providing the ferrofluid as a stabilized aqueous suspension of ferrite particles.

15. The method of claim 1, wherein the step of introducing a mixture of the particulate feed and the ferrofluid includes the step of providing the ferrofluid with a surfactant mixed therein.

16. The method of claim 1, wherein the step of providing includes the step of providing the magnet structure as a permanent magnet.

17. The method of claim 1, including an additional step, after the step of permitting, of

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analyzing at least one of the first particle fraction and the second particle fraction.

18. The method of claim 1, including an additional step, after the step of permitting, of physically sizing the second particle fraction.